



## Project Introduction

Root zone soil moisture (RZSM) provides a key link between surface hydrology and deeper processes. Biomass also plays a critical role in regulating the carbon cycle, with forests storing nearly the same amount of carbon as the atmosphere. In spite of its importance RZSM is not directly measured by any current satellite instrument. Model assimilation of surface measurements or indirect estimates from other observations must be used to infer this quantity. The objective of SoOp-AD is to develop an airborne demonstrator of a new microwave remote sensing instrument to directly measure RZSM. Signals of Opportunity (SoOp) methods exploit reflected signals at VHF and S-band. This has many of the benefits of both active and passive microwave remote sensing. Reutilization of active transmitters, with forward-scattering geometry, presents a strong reflected signal even at orbital altitudes. SoOp will not be limited to a few protected frequencies and is far less susceptible to radio-frequency interference (RFI). These unique features of SoOp circumvent past obstacles to a spaceborne VHF remote sensing mission and have the potential to enable new RZSM measurements that are not possible with present technology. A spaceborne SoOp instrument would have a substantially smaller antenna (75 X 75 cm) than a radiometer and require an order of magnitude lower power than radar, while meeting soil moisture (SM) science requirements with a 1 km resolution. SoOp-AD addresses both goals of the IIP: Enabling new Earth observations and reducing the cost and size of Earth observing instruments. A two-year instrument development will transform a current TRL3 breadboard design to TRL4. Flight demonstrations over a Soil Moisture Active Passive (SMAP) calibration and validation site will take place in year 3, exiting the program at TRL5. A subsequent development path to a satellite instrument is well defined. SoOp-AD would also be available for airborne science.

- Develop new microwave remote sensing instrument to directly measure root zone soil moisture (RZSM) as opposed to currently derived RZSM products.
- Enable spaceborne Signals of Opportunity (SoOp) measurement technique that would lead to a substantially smaller antenna (75 x 75 cm) than a radiometer and require orders of magnitude lower power than radar while meeting 1 km resolution
- Develop an airborne instrument to demonstrate concepts of SoOp reflectometry at VHF and S-band frequency ranges for RZSM.

## Anticipated Benefits

SMAP



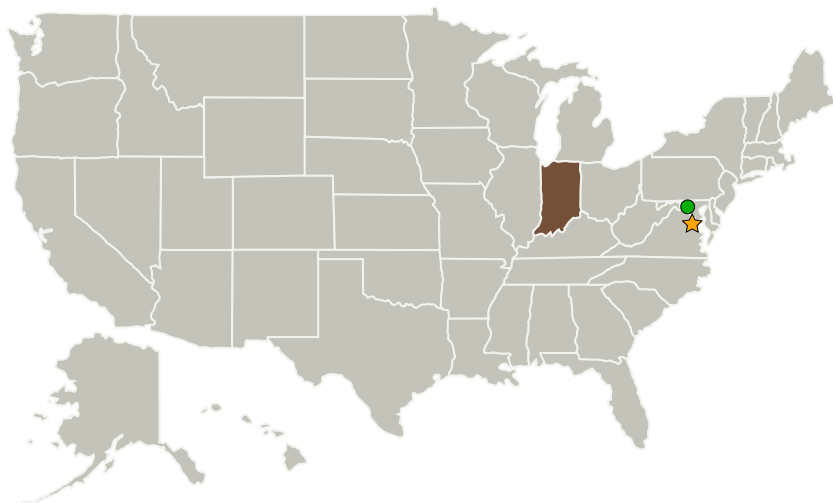
ALHAT - ETD Autonomous  
Landing & Hazard Avoidance  
Tech Earth Science Technology  
Office

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## Primary U.S. Work Locations and Key Partners



Organizations Performing Work	Role	Type	Location
★ NASA Headquarters(HQ)	Lead Organization	NASA Center	Washington, District of Columbia
● Goddard Space Flight Center(GSFC)	Supporting Organization	NASA Center	Greenbelt, Maryland
Purdue University-Main Campus	Supporting Organization	Academia	West Lafayette, Indiana

### Primary U.S. Work Locations

Indiana

## Organizational Responsibility

### Responsible Mission Directorate:

Science Mission Directorate (SMD)

### Lead Center / Facility:

NASA Headquarters (HQ)

### Responsible Program:

Instrument Incubator

## Project Management

### Program Director:

Pamela S Millar

### Program Manager:

Parminder S Ghuman

### Principal Investigator:

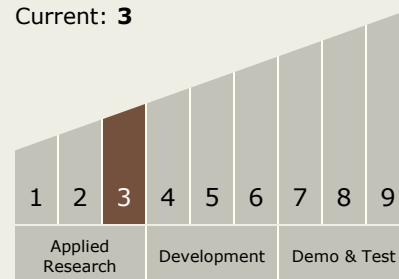
James Garrison

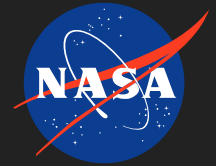
### Co-Investigator:

Michael R Ludwig

## Technology Maturity (TRL)

Start: 3  
Current: 3





## Images



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Science Technology Office  
(<https://techport.nasa.gov/image/5133>)

## Technology Areas

### Primary:

- TX08 Sensors and Instruments
  - └ TX08.1 Remote Sensing Instruments/Sensors
    - └ TX08.1.4 Microwave, Millimeter-, and Submillimeter-Waves

## Target Destination

Earth